LIFE OF NON SOLID ALUMINUM ELECTROLYTIC CAPACITORS
非固体铝电解电容的寿命推算

The life of aluminum electrolytic capacitors is mainly dependent on environmental conditions (e.g. ambient temperature, humidity etc.) and electrical factors (e.g. operating temperature, ripple current etc.) Generally, the wear-out mechanism of aluminum electrolytic capacitors is based on evaporation of electrolyte through the rubber seal. Consequently, the factor of temperature (ambient temperature and internal heating due to ripple current) is the most critical to electrolytic capacitors life. The effect of voltage on capacitor life is negligible, especially for low voltage electrolytic capacitors. The lifetime of aluminum electrolytic capacitors can be expressed as following equations. The estimated life-span is limited up to 15 years.
铝电解电容器的寿命主要依赖于其使用的环境条件（如环境温度、湿度等）和电气负荷情况（如工作电压、纹波电流）。通常而言，铝电解电容器的失效机理被认为是电解液通过封口胶塞散逸所导致。因此，温度因素（环境温度和由于纹波电流所导致的自身发热）对电容寿命的影响最大，而电压对电容器寿命的影响可以忽略，尤其对低电压铝电解电容器更是如此。铝电解电容器的预期使用寿命可以通过下式来估算，但产品的最长使用期限为 15 年。

❶ Calculation formula of estimated life expectancy　预期使用寿命推算公式

$$L_x = L_0 \times K_t \times K_r$$

Where:　其中:
- Lx : Life expectance (h) in actual use (temperature Tx)　预期使用寿命
- Lo : Guaranteed (h) at maximum temperature in use　在最高工作温度下的保证时间
- Kt : Ambient temperature acceleration term　环境温度影响因子
- Kr : Ripple current acceleration term　纹波电流影响因子

❷ Ambient temperature acceleration term　环境温度影响因子

$$K_t = B^{\frac{T_o - T_a}{10}}$$

Where:　其中:
- To: Maximum operating temperature (℃)　最高工作温度
- Ta: Actual ambient temperature (℃)　实际工作环境温度
- B: Acceleration coefficient (for the range from 35℃ to the maximum operating temperature, B≈2)
  加速系数（对于从 35℃到最高工作温度的范围，B≈2）

❸ Ripple current acceleration term　纹波电流影响因子

1).For a capacitor whose Endurance specifications are defined by only “the DC rated voltage”.　普通型铝电解电容品

$$K_r = 2^{\frac{-\Delta T}{5}}$$

2).For a capacitor whose Endurance specifications are defined by “the rated ripple current with a DC voltage superimposed”.　高频低阻抗品

$$K_r = 2^{\frac{(\Delta T_o - \Delta T)}{5}}$$

Where:　其中:
- ΔTo: Rise of internal temperature due to the rated ripple current (℃)　额定纹波电流引起的温升
- ΔT: Rise of internal temperature due to actual ripple current (℃)　由于纹波电流引起的自身实际温升

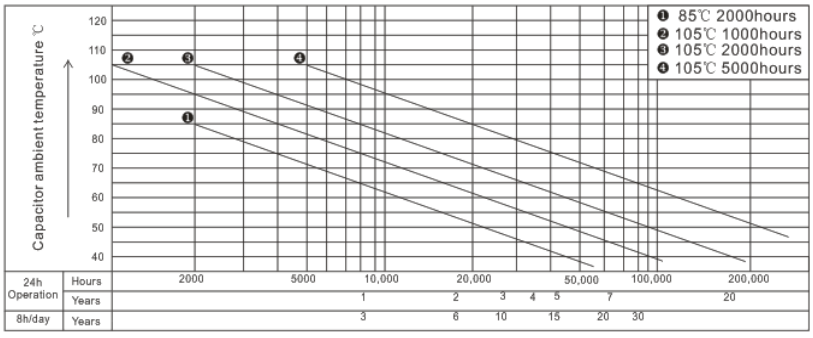
❹ Heat Generation due to Ripple Current　纹波电流引起的温升

An approximate value of ripple current-caused ΔT can be calculated using following Equation:
由于纹波电流引起的温升可以通过以下公式近似计算：

$$\Delta T_o = \left(\frac{I_x}{I_o}\right)^2 \times \Delta T$$

Where:　其中:
- Ix: Operating ripple current (Arms) actually flowing in the capacitor　实际工作纹波电流
- Io: Rated ripple current (Arms), frequency compensated, at the upper limit of the category temperature range　特定频率下的额定纹波电流

❺ Quick Reference Guide of the Expected Life　预期寿命快速参考



Example: When a 2000 hours/105℃ guaranteed products is used continuously at 60℃ , it can be expected to have a life of 5 years.
示例：对于 105 2000 小时的产品， 如果在 60 环境中连续使用，它的估算寿命约为 5 年。